39. The method of claim 31 wherein, in positioning, the thermal interface material capable of melting at a wave soldering preheat temperature is selected from the group consisting of a phase change thermal interface material and a thermal grease.

40. The method of claim 31, wherein mounting the heat-producing component to the substrate comprises:

electrically and/or mechanically coupling the heat-producing component to the substrate.

41. The method of claim 31 wherein, in mounting, the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.

REMARKS

Claim 16 has been canceled. Claims 1-3, 12, 13, and 17 have been amended.

New claims 31-41 have been added. As a result, claims 1-15 and 17-41 are now pending in this application.

An Information Disclosure Statement identifying U. S. Pat. No. 6,392,888 is submitted herewith. In addition, a Declaration Under 37 C.F.R. §1.131, with accompanying exhibits, is submitted herewith. To the extent that the Examiner may find U. S. Pat. No. 6,392,888 to be relevant with respect to Applicant's claimed subject matter, Applicant respectfully requests that the Examiner make a determination that Applicant has successfully antedated the effective date of U. S. Pat. No. 6,392,888.

Amendments to Claims 1-3, 12, 13, and 17

Claims 1-3, 12, 13, and 17 have been amended. No new matter has been introduced.

Claim 1 has been amended to recite that the substrate has at least one hole therein, and that the at least one mounting pin of the heat sink is soldered into the at least one hole of the substrate. In addition, "couple" has been substituted for "bond". Support may be found, for example, in original claim 2 and in the original written description in the paragraph beginning on

page 3, line 27.

Claim 2 has been amended to recite that the at least one mounting pin is wave-soldered to attach the heat sink to the substrate and to preheat and couple the heat sink to the heat-producing component with the disposed thermal interface material. Support may be found, for example, in original claim 13 and in the original written description in the paragraph beginning on page 6, line 16, and in the paragraph beginning on page 7, line 7.

In claims 3 and 12, the dependency has been changed from claim 2 to claim 1. Also, in claim 3, the word "and" has been inserted before the last "wherein" clause.

Claim 13 has been amended to recite that the substrate has at least one hole therein, and that the at least one mounting pin of the heat sink is soldered into the at least one hole of the substrate. Support may be found, for example, in original claim 16.

In claim 17, the dependency has been changed from 16 to claim 13. Also, the language "onto the substrate" has been deleted. Further, "the" has been substituted for "a corresponding".

New Claims 31-41

New claims 31-41 have been added to provide Applicant with additional protection to which Applicant is entitled. No new matter has been introduced.

Claim 31 is similar to independent method claim 13, as amended, except that claim 31 recites positioning a layer of thermal interface material on a heat sink having at least one mounting pin, and mounting a heat-producing component to a substrate having at least one hole therein. Support may be found, for example, in original claims 6 and 25.

Claims 32-41 contain limitations that are identical to those in claims 14-15 and 17-24, as amended.

Conclusion

Applicant respectfully submits that claims 1-15 and 17-41 are in condition for allowance, and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney Kash Nama at 603-888-7958 or the below signed attorney to facilitate prosecution of this application.

Respectfully submitted,

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Date December 6, 2002 By Ann M McCrackin
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I hereby certify that this paper is being transmitted by facsimile to the U.S. Patent and Trademark Office on the date shown below.

Jane E. Sagers

December 6, 2002
Date of Transmission

Docket No. 00884.462US1 Client Ref. No. P11292

Clean Version of Pending Claims

ELECTRONIC ASSEMBLY WITH SOLDERABLE HEAT SINK AND METHODS OF MANUFACTURE
Applicant: George Hsieh
Serial No.: 09/897,320

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1. (Twice Amended) An electronic assembly comprising:

a substrate having at least one hole therein;

a heat sink having at least one mounting pin; and

at least one heat-producing component attached to the substrate, wherein the heat sink is disposed over the at least one heat-producing component and the substrate, wherein the heat-producing component is sandwiched between the substrate and the heat sink, wherein a thermal interface material is disposed between the heat sink and the heat-producing component to couple the heat sink to the heat-producing component, and wherein the at least one mounting pin of the heat sink is soldered into the at least one hole of the substrate.

2. (Twice Amended) The electronic assembly of claim 1, wherein the at least one mounting pin is wave-soldered to attach the heat sink to the substrate and to preheat and couple the heat sink to the heat-producing component with the disposed thermal interface material.

3. (Twice Amended) The electronic assembly of claim 1, wherein the heat sink further comprises:

a thermally conductive plate, wherein the heat-producing component has front and back sides, the front side being disposed across from the back side, wherein the thermally conductive plate is coupled to the back side and the substrate is attached to the front side, and wherein the at least one mounting pin extends beyond the thermally conductive plate and the at least one mounting hole.

4. The electronic assembly of claim 3, wherein the heat sink further comprises:

a heat exchange portion, wherein the heat exchange portion extends beyond the thermally conductive plate and is disposed across from the heat-producing component.

5. The electronic assembly of claim 4, wherein the heat exchange portion comprises:

multiple fins extending away from the thermally conductive plate.

6. The electronic assembly of claim 3, wherein the thermal interface material is disposed between the heat sink and the back side of the heat-producing component.

7. The electronic assembly of claim 6, wherein the thermal interface material is selected from the group consisting of a phase change thermal interface material and a thermal grease.

8. The electronic assembly of claim 3, wherein the substrate is electrically and/or mechanically attached to the front side of the heat-producing component.

9. The electronic assembly of claim 1, wherein the heat sink is made from a material selected from the group consisting of copper and aluminum.

10. The electronic assembly of claim 1, wherein the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.

11. The electronic assembly of claim 1, wherein the substrate is a printed circuit board.

12. (Twice Amended) The electronic assembly of claim 1, wherein the at least one mounting pin is disposed in the at least one mounting hole and wave-soldered during a pre-assembly operation.

13. (Twice Amended) A method comprising:

mounting a heat-producing component to a substrate having at least one hole therein;

positioning a layer of thermal interface material onto the heat-producing component;

aligning a heat sink including at least one mounting pin over the thermal interface material such that the thermal interface material is sandwiched between the heat-producing component and the heat sink, and further the at least one mounting pin is disposed over the substrate for soldering the at least one mounting pin to the substrate;

reducing the viscosity of the thermal interface material by preheating the thermal interface material in a pre-heater of a wave soldering machine to cause the thermal interface material to wet the heat-producing component to thermally couple the heat sink to the heat-producing component; and

attaching the heat sink in a fixed position on the heat-producing component and the substrate by soldering the at least one mounting pin into the at least one hole of the substrate.

14. The method of 13, wherein reducing the viscosity of the thermal interface material comprises:

loading the substrate including the heat producing component, thermal interface material, and the heat sink onto a conveyor of the wave soldering machine; and

preheating the thermal interface material using the preheater to cause the thermal interface material to wet the heat-producing component.

15. The method of claim 14, further comprising:

cooling the at least one mounting pin to mechanically fix the heat sink in place.

17. (Twice Amended) The method of claim 16, wherein soldering the at least one mounting pin comprises:

disposing the at least one mounting pin of the heat sink through the at least one hole in the substrate; and

wave soldering the at least one mounting pin to the substrate.

18. The method of claim 13, further comprising:

forming the heat sink including a thermally conductive plate such that the at least one mounting pin extends beyond the thermally conductive plate.

19. The method of claim 18, wherein forming the heat sink further comprises:

forming a heat exchange portion such that the heat exchange portion extends beyond the thermally conductive plate and across from the heat-producing component.

20. The method of claim 19, wherein forming the heat exchange portion comprises:

forming multiple fins extending away from the thermally conductive plate.

21. The method of claim 13 wherein, in aligning, the heat sink is made from a material selected from the group consisting of copper and aluminum.

22. The method of claim 13 wherein, in positioning, the thermal interface material capable of melting at a wave soldering preheat temperature is selected from the group consisting of a phase change thermal interface material and a thermal grease.

23. The method of claim 13, wherein mounting the heat-producing component to the substrate comprises:

electrically and/or mechanically coupling the heat-producing component to the substrate.

24. The method of claim 13 wherein, in mounting, the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.

25. A method comprising:

mounting a heat-producing component onto a substrate having at least one mounting hole therein;

aligning a heat sink having at least one mounting pin to the substrate, with the at least one mounting pin inserted into the at least one mounting hole;

positioning a thermal interface material between the heat-producing component and the heat sink; and

using a wave soldering process to cause the thermal interface material to wet and bond the heat sink and the heat-producing component and to solder the at least one mounting pin to the at least one mounting hole.

26. The method of claim 25, further comprising:

forming the heat sink to have a thermally conductive plate, wherein the at least one mounting pin extends beyond the thermally conductive plate.

27. The method of claim 26, wherein forming the heat sink further comprises:

forming a heat exchange portion that extends beyond the thermally conductive plate and is disposed across from the heat-producing component.

28. The method of claim 27 wherein, in aligning, the heat sink is made from materials selected from the group consisting of copper and aluminum.

29. The method of claim 25 wherein, in positioning, the thermal interface material capable of melting at a wave soldering preheat temperature is selected from the group consisting of a phase change thermal interface material and a thermal grease.

30. The method of claim 25 wherein, in mounting, the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.

31. A method comprising:

positioning a layer of thermal interface material on a heat sink having at least one mounting pin;

mounting a heat-producing component to a substrate having at least one hole therein;

aligning the heat sink over the heat-producing component such that the thermal interface material is sandwiched between the heat-producing component and the heat sink, and further such that the at least one mounting pin is disposed for soldering to the substrate;

reducing the viscosity of the thermal interface material by preheating the thermal interface material in a pre-heater of a wave soldering machine to cause the thermal interface material to wet the heat-producing component to thermally couple the heat sink to the heat-producing component; and

attaching the heat sink in a fixed position on the heat-producing component and the substrate by soldering the at least one mounting pin into the at least one hole of the substrate.

32. The method of 31, wherein reducing the viscosity of the thermal interface material comprises:

loading the substrate including the heat-producing component, thermal interface material, and the heat sink onto a conveyor of the wave soldering machine; and

preheating the thermal interface material using the preheater to cause the thermal interface material to wet the heat-producing component.

33. The method of claim 32, further comprising:

cooling the at least one mounting pin to mechanically fix the heat sink in place.

34. The method of claim 31, wherein soldering the at least one mounting pin comprises:

disposing the at least one mounting pin of the heat sink through the at least one hole in the substrate; and

wave soldering the at least one mounting pin to the substrate.

35. The method of claim 31, further comprising:

forming the heat sink including a thermally conductive plate such that the at least one mounting pin extends beyond the thermally conductive plate.

36. The method of claim 35, wherein forming the heat sink further comprises:

forming a heat exchange portion such that the heat exchange portion extends beyond the thermally conductive plate and across from the heat-producing component.

37. The method of claim 36, wherein forming the heat exchange portion comprises:

forming multiple fins extending away from the thermally conductive plate.

38. The method of claim 31 wherein, in aligning, the heat sink is made from a material selected from the group consisting of copper and aluminum.

39. The method of claim 31 wherein, in positioning, the thermal interface material capable of melting at a wave soldering preheat temperature is selected from the group consisting of a phase change thermal interface material and a thermal grease.

40. The method of claim 31, wherein mounting the heat-producing component to the substrate comprises:

electrically and/or mechanically coupling the heat-producing component to the substrate.

41. The method of claim 31 wherein, in mounting, the heat-producing component is an integrated circuit device selected from the group consisting of a chipset, a microprocessor, a digital signal processor, and an application-specific integrated circuit device.